ISSN 0704-3716

Canadian Translation of Fisheries and Aquatic Sciences

No. 5389

Reproduction and sex composition of the North Atlantic rock grenadier

P. I. Savvatimskii

Original title: Razmnozhenie i polovoi sostav tuporylogo makrurusa Severnoi Atlantiki

In: Chislennost' i obraz zhizni promyslovykh rib Severo-zapadnoi Atlantiki. Tr. Polyarn. Nauchno-issled. Inst. Morsk. Rybn. Khoz. Okeanogr. N. M. Knipovicha - PINRO (no volume number): 32-53. 1982.

Original language: Russian

Available from:
Canada Institute for Scientific and Technical Information
National Research Council
Ottawa, Ontario, Canada K1A 0S2

1988

33 typescript pages

Secretary of State / Secrétariat d'État

90-01549/

MULTILINGUAL SERVICES DIVISION – DIVISION DES SERVICES MULTILINGUES

TRANSLATION BUREAU BUREAU DES TRADUCTIONS

LIBRARY IDENTIFICATION – FICHE SIGNALÉTIQUE

Translated from - Traduction de	Into - En
Russian	English

Author - Auteur

P.I. Savvatimskii

Title in English or French - Titre anglais ou français

REPRODUCTION AND SEX COMPOSITION OF THE NORTH ATLANTIC ROCK GENADIER

Title in foreign language (Transliterate foreign characters)
Titre en langue étrangère (Transcrire en caractères romains)

Razmnozhenie i polovoi sostav tuporylogo makrurusa Severnoi Atlantiki

Reference in foreign language (Name of book or publication) in full, transliterate foreign characters.
Référence en langue étrangère (Nom du livre ou publication), au complet, transcrire en caractères romains.

Chislennost' i obraz zhizni promyslovykh rib Severo-zapadnoi Atlantiki

Reference in English or French - Référence en anglais ou français

Abundance and mode of life of fishes of the northwest Atlantic

Publisher - Éditeur	DATE OF PUBLICATION / DATE DE PUBLICATION			Page Numbers in original / Numéros des pages dans l'original
PINRO	Year / Année	Volume	Issue No. / Numéro	32-53
Place of Publication / Lieu de publication				Number of typed pages / Nombre de pages dactylographiées
Murmansk	1982	—	—	29

Requesting Department / Ministère-Client: DFO

Branch or Division / Direction ou Division: IPB

Person requesting / Demandé par: Nancy Johnson

Your Number / Votre dossier nº: —

Date of Request / Date de la demande: 20.IV.88

Translation Bureau No. / Notre dossier nº: 2792068

Translator (Initials) / Traducteur (Initiales): NKM

UNEDITED TRANSLATION
For information only
TRADUCTION NON REVISÉE
Information seulement

JUN - 1 1988

Canada

SEC 5-111 (84-10)

Secretary of State | Secrétariat d'État

MULTILINGUAL SERVICES DIVISION – DIVISION DES SERVICES MULTILINGUES

TRANSLATION BUREAU | BUREAU DES TRADUCTIONS

Client's No.–N° du client	Department – Ministère	Division/Branch – Division/Direction	City – Ville
—	DFO	IPB	
Bureau No.–N° du bureau	**Language – Langue**	**Translator (Initials) – Traducteur (Initiales)**	
2792068	Russian	NKM	JUN - 1 1988

Source: Transactions of the Polar Scientific-Research Institute of Marine Fisheries and Oceanography im. N.M. Knipovich, PINRO. Abundance and mode of life of commercial fishes of the northwest Atlantic (collection of scientific papers). Murmansk. 1982. ISSN 0376-1460

UNEDITED TRANSLATION
For information only
TRADUCTION NON REVISEE
Information seulement

UDC 597.561 (261.4)

REPRODUCTION AND SEX COMPOSITION OF THE NORTH ATLANTIC ROCK GRENADIER

P.I. Savvatimskii

The study of the ecology of grenadiers of the North Atlantic is important to the further development and improvement of deep-sea fishing. To date the mode of life of grenadiers has not been studied sufficiently because of their deep-sea habitat; different and often contradictory information is given in the scientific literature on their distribution, migrations, fecundity and spawning seasons and duration. |32

Marshall (1965) provides the most complete information on the reproduction of grenadiers. The roe of grenadiers, like that of most Gadiformes or Anacanthini is pelagic with a fat drop. The eggs have the characteristic reticulate membrane of hexagonal structure (Sanzo, 1933). G.V. Grigor'ev and Serebryakov (1981) studied the development of the eggs of rock grenadier from fertilization to the early embryo stage. According to their data the reticulate membrane of eggs with a diameter of 2.3-2.4 mm is indistinct, and the cells have an irregular tetragonal shape. Marshall hypothesized that

genadiers spawn and fertilize the roe at the bottom, then as the eggs develop they rise to the upper layers of water. The larvae and fingerlings descend into the deep waters as they develop. Thus, for example, the plankton larvae of Trachyrhynchus trachyrhynchus descend in their second year of life from a depth of 300 m to 400-500 m, and later to a depth of 600-800 m where the fish subsequently reach sexual maturity (Ibanez, 1977). The larvae of Coryphaenoides acrolepis under 6.7 mm long (to the end of the chord) were caught in the northern part of the Pacific Ocean at a depth of 200 m; studies showed that they migrate to a depth of 1400 m as they grow (Stein, 1980). Marshall ascertained that grenadier larvae 5-20 mm long are found at a depth of 200-300 m, and larvae 50 mm long - at /33
a depth of 900 m. Merrett (1978) reports a catch of grenadier larvae and fingerlings in April and May of 1971 south of Iceland away from the banks and continental slopes. All of the larvae were caught in the upper 900-meter layer, and fingerlings - at depths of 700-2000 m. Rock grenadier larvae with a head 0.4-1.4 mm long were caught at depths of 25-500 m, and with a head 1.4-4 mm long - at depths of 500-900 m. The larvae of various grenadier species have very elongated fin rays, which facilitate soaring in the water mass. Typical of the larvae of rock grenadier is a very short abdominal section with pigmentation in the form of stellate melanophores, and with a developed swim bladder. In individuals with a head length of 1.9 mm and larger gill rakers, the brachiostegal rays and fin rays are formed; the fin fold connects both dorsal fins. During the course of development the vertebral stem ossifies (at a head length of 3.1 mm), and the fin rays complete their formation (at a head length of 3-4 mm) as do the gill rakes (at a head length of 6-7 mm). Large individuals inhabit deeper waters than do smaller individuals; this is the general pattern of distribution of the young and adult mesopelagic and bathypelagic fish (Vinogradov, 1959).

At depths of 750-6000 m in the Pacific, Atlantic and Indian oceans, sexually mature grenadiers more than 1 m long were found (Isaacs, Schwartzlose,

1975); females close to spawning were caught at the bottom, but the catches did not contain immature fish or eggs. Fingerlings of Pacific Ocean grenadiers have repeatedly been caught in the water mass above deep levels (Hubbs, Iwamoto, 1977).

Grenadier larvae occur extremely rarely both in the open part of the ocean and above the continental slope. Johnsen (1927) reports a catch of genadier larvae in the open part of the ocean outside the 2000 m isobath at depths of 650-850 m and notes that a bathypelagic mode of life is characteristic of the larvae. Like Marshall (1965), he hypothesizes that this is an adaptive property, protecting the slightly mobile larvae from being eaten up by numerous predators in the well illuminated upper layers of the ocean. More larvae were caught at a depth of 850 m than at 650 m; this could be related to the fishing gear used (at a depth of 650 m the catch was made with an egg net, and at a depth of 850 m - with a fingerling trawl) and also to the increase in the numbers of larvae with depth. Not a single larva was caught at depths less than 650 m. Some of the larvae that were caught were found to be very similar to rock grenadier larvae however their exact systematic position could not be determined.

The fishing of rock grenadier (Coryphaenoides rupestris) in the north /34
Atlantic is based on the accumulations of sexually immature fish. No spawning sites of rock genadier were found here. Also non-spawning fish of this species which were close to spawning were caught near Iceland; this led to the assumption of the possibility of non-spawning migrations of grenadiers from the northwest Atlantic to the northeast (Zakharov, Mokanu, 1970; Podrazhanskaya, 1971). The grenadiers of most species are endemic, but individual species have vast ranges. Thus, Malacocephalus laevis, an inhabitant of the slopes, occurs in the Atlantic (eastern part), Indian and Pacific (western part) oceans. No differences were found when grenadiers caught in the regions of Zanzibar and the Maldive Islands were compared with the grenadiers of the Atlantic Ocean (Marshall, 1965). Morphometric studies conducted by ichthyologists of the German Democratic

Republic (Zukowski, 1972) revealed many similar traits in the rock grenadier of Iceland, Labrador and Baffin Island. All of this can serve to underline the hypothesis that rock grenadiers make long migrations over large distances.

The French investigators Hureau, Geistdoerfer and Rannou, 1979) note that one and the same species of deep-sea fish can be found at opposite points of the World Ocean, and they believe that deep-sea currents play a special role in the distribution of these fish. Migrations of adult rock grenadiers from the northwest Atlantic to the northeast and back are considered to be unlikely; however, the passive transport of eggs and larvae by strong currents is possible. It is entirely probable that many larvae are transported from the region of Iceland or another reproduction region to Baffin Island and Labrador. It is known that grenadier fingerlings 7-8 cm are encountered along the entire continental slope of Canada (Grigor'ev, 1972), and larvae 3.5 mm long - near Greenland (Jensen, 1948) and in the northest Atlantic (Johnsen, 1927; Merrett, 1978). Proceeding from this, we should expect that the progeny of populations of rock grenadiers inhabiting the North-central Atlantic supplements the population living near Canada. Also, it is not exluded that the eggs and larvae of grenadier are transported by the Gulf Stream in a northeasterly direction; that is, these groups of populations are in some measure interconnected.

In the opinion of some investigators, rock grenadier do not make extensive migrations (Grigor'ev, 1972; Pechenik, 1970; Savvatimskii, 1972; Marshall, 1965) and should not be regarded as good swimmers (Vinichenko, 1979; Serebrov, 1974). At one and the same length, rock grenadier weigh more in the region of Iceland than in the northwest Atlantic (Savvatimskii, 1969); this is possibly the result of different feeding conditions. This fact supports the hypothesis that there are various groups of fish near Iceland and in the northwest Atlantic. /35

Ye.I. Alekseeva (1978), F.Ye. Alekseev, Ye.I. Alekseeva and N.V. Titova (1978), on the basis of a study of the electrophoretic spectrum of the muscular

esterases and the sex ratio in populations, found that the rock grenadier in the northern, central and southern parts of the Reykjanes Ridge differ in many traits. The authors regard the populations of these three regions as reproductively independent. According to our investigations, conducted in 1972-1974, the otoliths of the grenadier of the northern ($62^{o}30'$ N. lat.) and southern ($53^{o}20'$ N. lat.) parts of the Reykjanes Ridge differ in weight in fish of the same weight or length (Fig. 1, 2). Grenadier residing further north have /36 lighter otoliths. These differences are statistically reliable.

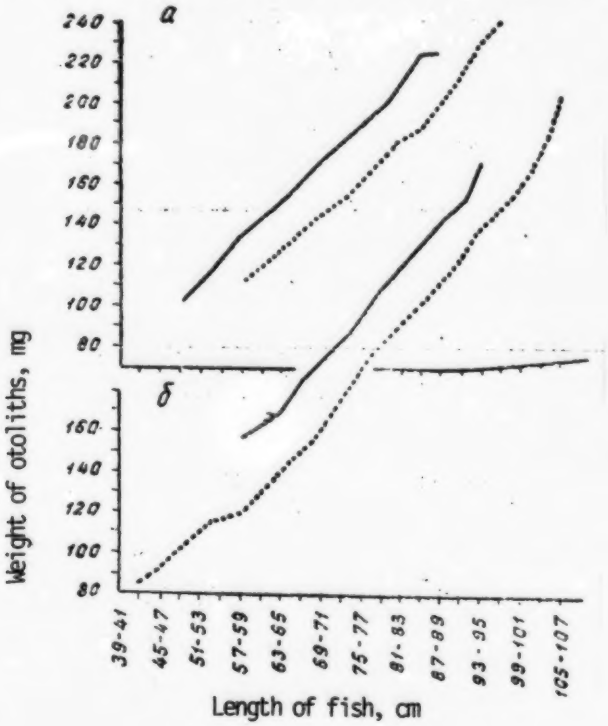

Fig. 1. Ratio between the weight of the otoliths of the males (a) and females (b) of rock grenadier of the southern (solid line) and northern (dotted line) parts of Reykjanes Ridge (2411 otoliths)

Similar results were obtained by K.P. Yanulov (1960) while studying the otoliths of sea bass, which form the local stock off Newfoundland and Labrador. He writes: "The general pattern for populations of Norway haddock and deepwater

redfish is the reduction in the weight of the otoliths with advancement to the northern regions of their habitat".

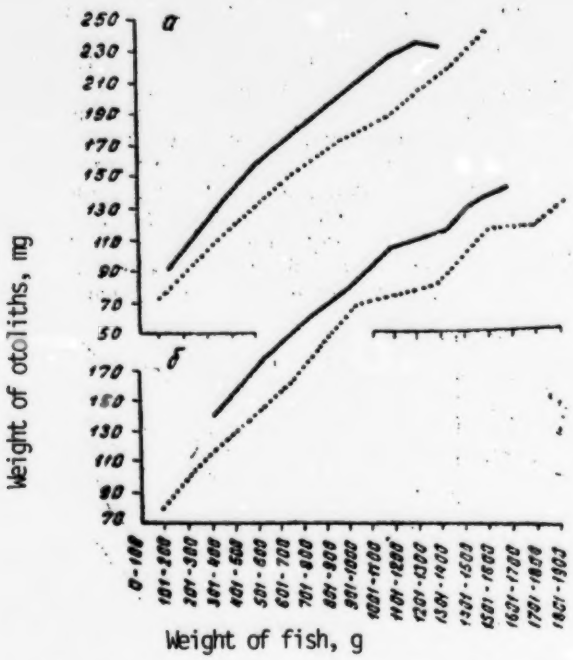

Fig. 2. Ratio between the weight of the otoliths and the weight of the males (a) and females (b) of the rock grenadiers of the southern (solid line) and northern (dotted line) of parts of Reyjanes Ridge (2420 otoliths)

The otoliths of the grenadiers of the northern and southern parts of the Reykjanes Ridge also differed in form (Fig. 3). Given the same width, otoliths of grenadier of the northern region are longer.

The degree of parasite infestation of rock grenadier of various regions of the north Atlantic differs. Szuks (1975) indicates that 74% of the 32 fishes studied in the Labrador region were infested with trematodes, and all the 47 fishes caught off the /37 Norwegian coast were free of trematodes. This indicates the isolation of groupings of grenadier. The same author notes that in different parts of the continental slope of Labrador, the grenadier is infested with different parasites, and he

concludes that populations of fish without common spawning grounds are isolated (Szuks, 1980).

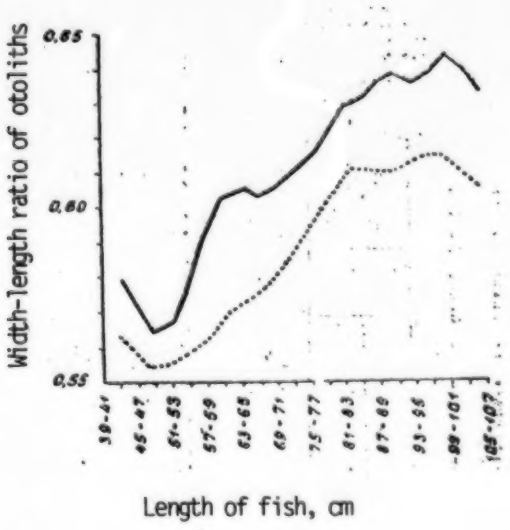

Fig. 3. The relationship between the width of the otolith and its length in in rock grenadier of different lengths in the southern (solid line) and northern (dotted line) parts of the Reykjanes Ridge (2542 otoliths)

A number of investigators suggest that rock grenadier spawn at deep depths that have not yet been touched by the fishery (Grigor'ev, 1972; Pechenik, 1970; Pechenik, 1970; Pechenik and Troyanovskii, 1969, 1970; Savvatimskii, 1969). Rock grenadier approximately 7 cm long were found in trawl catches on the Canadian continental slope at depths of approximately 900 m, which supports such a hypothesis. We also know that in deep-sea fishes (with few exceptions), sexually mature individuals predominate at the deepest depths of the habitat of the species and reproduce there (Vinogradov, 1959). Thus, for example, the smalleye grenadier Chalinura pectoralis , which is very numerous in the northern part of the Pacific Ocean, does not make extended migrations and spawns at deep levels along the entire continental slope (Novikov, 1970). In recent years on the continental slope of Labrador

and Newfoundland, as well as off Nova Scotia, rock grenadier in a spawning state were found at great depths (to 1520 m).

There is no single opinion about the duration of spawning of deep-sea fish, particularly grenadier. T.S. Rass (1959) notes the brevity of the reproduction season of deep-sea fishes and suggests that this is associated more with the internal rhythm of vital activity than with change in environmental conditions. However, Marshall (1965) speaks of the lengthy spawning season of grenadiers in both the temperate and tropical latitudes. The smalleye grenadier /38 living in the northern part of the Pacific Ocean spawns practically year-round, but more intensively in the autumn and winter (Novikov, 1970; Novikov and Kodolov, 1973). The spawning of the banded hollowsnout in the region of southwestern Africa is also year-round (Trunov, 1973). The northern grenadier in western Iceland spawns throughout the year, but the peak of spawning occurs in November - February (Magnusson, 1977). Ye.F. Kleie (1967) suggests that the spawning period of far-eastern grenadier "extends throughout the year", and this is supported by investigations conducted in recent years (Poltov, Lagunov and Kurenkov, 1980).

There are different opinions concerning the spawning time of rock grenadier. On the basis that mature eggs were found in fish caught in the Norwegian fiords at a depth of approximately 200 m in October, and developed post-larval stages were caught in the Norwegian Sea in June and July, Marshall concludes that this species of grenadier reproduces at the beginning of the year. Judging by the results of the voyage of the scientific-research vessel "Talassa" in 1975-1976 on the Rockall and Hatton banks and in the region of the Iceland-Faroe threshold, rock grenadier spawn in the spring (April) and the length of the spawning period is short (Geistdoerfer, 1977). A.P. Andriashev (1954) times the reproduction of rock grenadier at late autumn and indicates a fecundity of 12-16.5 (to 35.5) thousand eggs with a diameter of approximately 1.8 mm. According

Characteristics of sexually mature females of rock grenadier on Hatton Bank in July, 1972 and August, 1979

Stage of maturity	Length of fish, cm		Weight of fish, g		Coefficent of maturity		Fecundity in the thousands		Number of fish	Diameter of eggs, mm		Number of measured eggs
	limits	average	limits	average	limits	average	limits	average		limits	average	
III	78—98	88,9	1100—2050	1493,8	2,3— 6,2	3,7	14,8—56,4	28,4	8	1,0—1,7	1,4	2400
IV	71—106	95,0	750—2400	1740,8	3,8—11,8	7,1	11,6—63,1	30,0	36	1,3—2,5	1,7	10812
V	92—101	96,5	1700—1800	1750,0	5,3— 7,0	6,2	5,9—12,0	9,0	2	2,2—2,5	2,4	600
III—V	71—106	94,0	750—2400	1698,3	2,3—11,8	6,5	5,9—63,1	28,8	46	1,0—2,5	1,7	13812

to the data of Ye.I. Alekseeva (1978), the fecundity of rock grenadier is 12-35 thousand eggs; the eggs are large with a diameter of approximately 3 mm, with a fat drop 0.8 mm in diameter. The males spawn in batches, female spawning is stretched out over a single period of time. /39

According to our data (Table 1), the fecundity of the rock grenadier of Hatton Bank caught in July, 1972 and August, 1979 varied from 6 to 63 thousand eggs. In many fish, particularly in stage V of maturity, some of the eggs were apparently pressed out when the trawl was lifted onto the deck; therefore, the fecundity of females in stage V of maturity was slightly low as was their coefficient of maturity, which was 6.2%. The most reliable coefficient of maturity and fecundity can be considered to be that of females in stage IV of maturity, which were sufficiently present in the collected samples. The coefficient of maturity varied from 3.8 to 11.8% (an average of 7.1), and the fecundity - from 11.6 to 63.1 thousand (an average of 30 thousand) eggs; the ovaries were filled with transparent eggs with an average diameter of 1.7 mm (Fig. 4). Usually, a small number of transparent eggs with a diameter of 2-2.5 mm with a fat drop of approximately 1 mm in diameter/ was found in the caudal part of the glands. In females of stage V of maturity, the ovaries were filled with precisely such ready-to-spawn eggs. The membrane of the ovaries of females in stages IV and V of maturity was covered with very tiny (diameter - 0.1-0.2 mm) non-transparent whitish eggs, which were not taken into account in the calculation of fecundity.

We also determined the individual fecundity of 83 female grenadier caught from July 1 to September 25, 1980 at depths of 510-1220 m in the southern part of the Reykjanes Ridge (from $48^{o}47'$ to $55^{o}21'$ N. lat, and from $28^{o}10'$ to $34^{o}10'$ W. long.). These data were combined with the data from Hatton Bank in order to determine the nature of the change in fecundity with the increased length and weight of the fish. The fecundity of 117 females 66 to 107 cm long and /41

weighing from 580 to 2500 g averaged 29560 eggs. The individual fecundity of rock grenadier, like that of other grenadier with one-time spawning (Lisovenko, 1980) increases with an increase in the length and weight of the indiviudals (Fig. 5). The relationship between the fecundity and length of the fish is close to cubic, and that between fecundity and weight - close to linear.

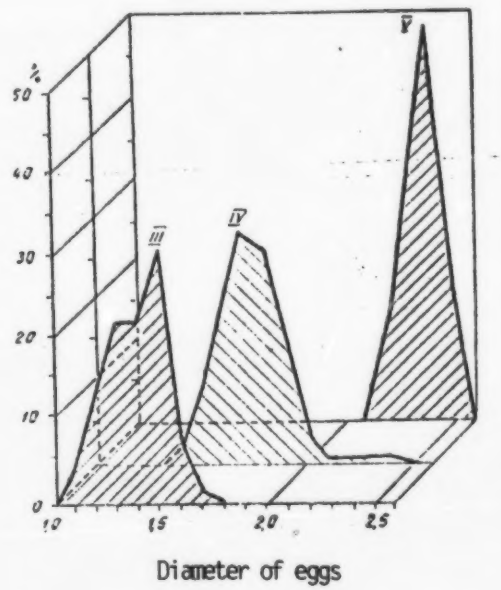

Fig. 4. Diameter of eggs of rock grenadier at stages III, IV and V of maturity on Hatton Bank in July, 1972 and August, 1979

Spawning rock genedier were found at various times of the year. At the end of October, 1968, northwest of Rockall Bank in the region bounded by coordinates $59^{o}02'$ - $57^{o}38'$ N. lat. and $18^{o}47'$ - $17^{o}40/$ W. long. at depths of 580-850 m, small catches were taken of a very large rock grenadier in a spawning and post-spawning state (Savvatimskii, 1969). In May, 1970, spawning rock grenadier were found at depths of 850-1270 m south of the penninsula of Nova Scotia (Savvatimskii, 1972). In both cases the number of fish close to spawning increased with the depth of the catch. On May 21, 1972, during a voyage of the scientific-industrial vessel "Artemida" of the peninnsula of Nova Scotia,

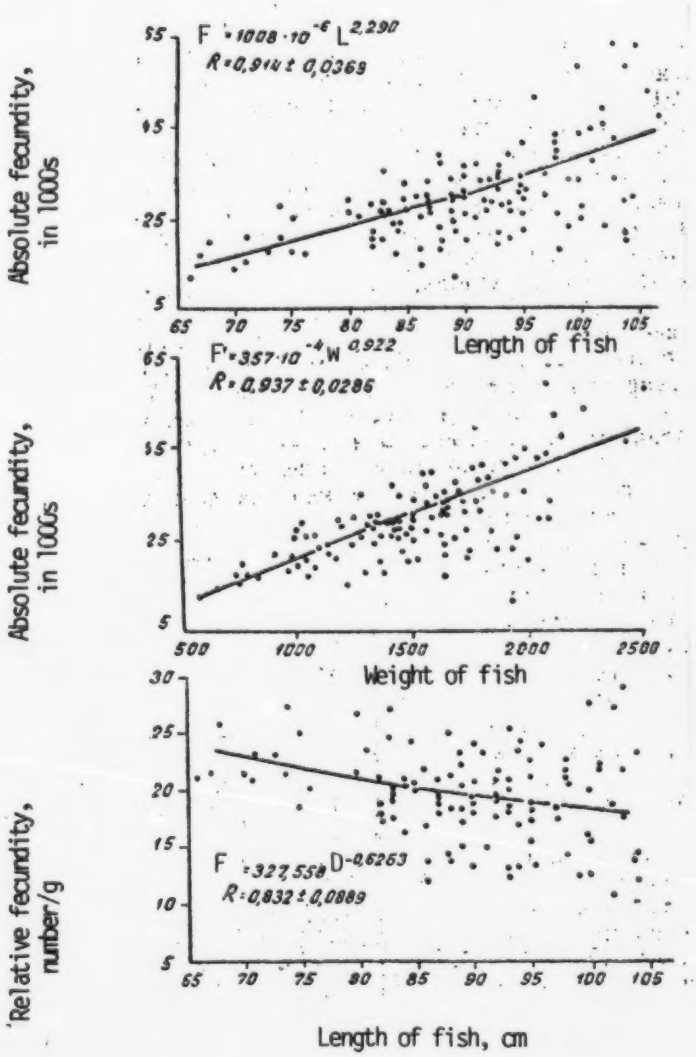
F = 1008 · 10⁻⁶ L^2,290
R = 0,914 ± 0,0369
Absolute fecundity, in 1000s
Length of fish
F = 357 · 10⁻⁴ W^0,922
R = 0,937 ± 0,0286
Absolute fecundity, in 1000s
Weight of fish
F = 327,558 D^-0,6263
R = 0,832 ± 0,0889
Relative fecundity, number/g
Length of fish, cm

Fig. 5. The relationship between fecundity (F), length (L) and weight (W) of rock grenadier of the north Atlantic (R is the ccefficient of correlation)

individual specimens of rock grenadier 70-105 cm long which were close to spawning were caught with a bottom trawl at depths of 1020-1130 m. Only sexually immature fish 29-63 cm long were found at shallower depths in this region.

In 1970, during the voyage of the research vessel of the German Democratic Republic Ernst Haeckel, spawning rock grenadier were found off the southern coast of Iceland in May at depths of 600-800 m (Zukowski, 1972). On January 15, 1972, during the voyage of the scientific-industrial vessel Persei-III, spawning grenadier were caught with a bottom trawl off the southwest coast of Iceland ($63^{o}01'$ N lat., $22^{o}36'$ W. long.) at depths of 725-770 m. The males were 52-97 cm long, and the females - 49-121 cm long. Only a small portion of the large fish was in a spawning state.

In 1972, during the voyage of the scientific-industrial vessel Artemida on Hatton Bank and the Reykjanes Ridge, rock grenadier were found in stage V of maturity. On Hatton Bank in October, the number of post-spawning females increased from 43 to 96%, and the number of males with flowing sexual products remained constant (approximately 45%). On the Reykjanes Ridge during this time, the number of sexually mature females increased from 11 to 61%. The fish close to spawning and the non-spawning fish virtually did not feed; the mean point-scale index of stomach fullness for males and females in stage V of maturity was 0.62 and 0.33, respectively. By the end of October, with an increase in the number of spawned-out fish on Hatton Bank, the mean index of stomach fullness increased. In July, males close to spawning had an average coefficient of maturity of 0.65%, and females - 6.5-7.3% (Table 2).

G.V. Grigor'ev (1972) studied the fish caught south of Iceland in May, /42
August and December, and came to the conclusion that there is no distinct seasonality of reproduction; this is associated with the difference in time of the maturation of different individuals and a relatively stable environment in

which spawning and the development of the eggs and larvae occur (the bathypelagial). Magnusson (1977), who studied the grenadier in this same region in March, May-July and October-November in various years, believes that this fish spawns throughout the entire year. Apparently, the peak of spawning of the rock grenadier takes place in July-December because PINRO scientific-research vessels caught fish in a spawning state more often during this period than at any other time of the year over a number of years in the most varied regions of the north Atlantic. It is possible that grenadier form local populations with different spawning periods, by which the apparent lengthiness of spawning during the year can be explained.

In January, 1972, near Spain (during the voyage of the scientific-industrial vessel Persei-III), sexually immature individuals up to 80 cm long and longer were caught together with spawning grenadier. Probably, rock grenadier reach sexual maturity at a later age than other grenadiers. Thus, for example, according to the hypothesis of Ye.B. Kulikova (1957), Pacific Ocean grenadiers - the black, ash-coloured and narrow-foreheaded - mature in the third year, but

Table 2

Weight of gonads of rock grenadier at differenct stages of sexual maturity

Stage of maturity	Hatton Bank, July 23, 1972					Reykjanes, July 2. 1972				
	length of fish, cm	weight of fish g	weight of gonads g	weight of gonads %	number of fish	length of fish cm	weight of fish, g	weight of gonads, g	weight of gonads, %	number of fish
				Males						
II	37,0	104	0,10	0,01	1	82,0	1096	0,62	0,06	93
III	79,8	890	2,76	0,31	26	91,1	1318	3,79	0,29	8
IV	85,2	1028	4,82	0,47	88	85,6	1140	9,90	0,87	5
V	87,1	1122	7,13	0,64	92	95,4	1507	16,07	1,07	14
				Females						
II	—	—	—	—	—	83,8	1280	5,61	0,44	153
III	88,9	1518	51,2	3,47	17	102,8	2125	98 80	4,64	10
IV	97,5	1816	133,3	7,34	30	91,0	1400	92,50	6,61	2
V	98,5	1812	117,2	6,47	4	—	—	—	—	—
VI	98,2	1902	70,8	3,73	12	—	—	—	—	—
VI—II	95,3	1658	22,7	1,37	30	108,9	2281	21,06	0,92	8

the smalleye - in the fourth year, reaching lengths of 68, 45, 41 and 57 cm. According to our data, on the Reykjanes Ridge and Hatton and Rockall banks, /43 sometimes individuals in the third stage of maturity are found among rock grenadier males 39 cm long and females 45 cm long. The number of sexually mature fish is greatest among males 78-80 cm and females 90-92 cm long (Fig. 6).

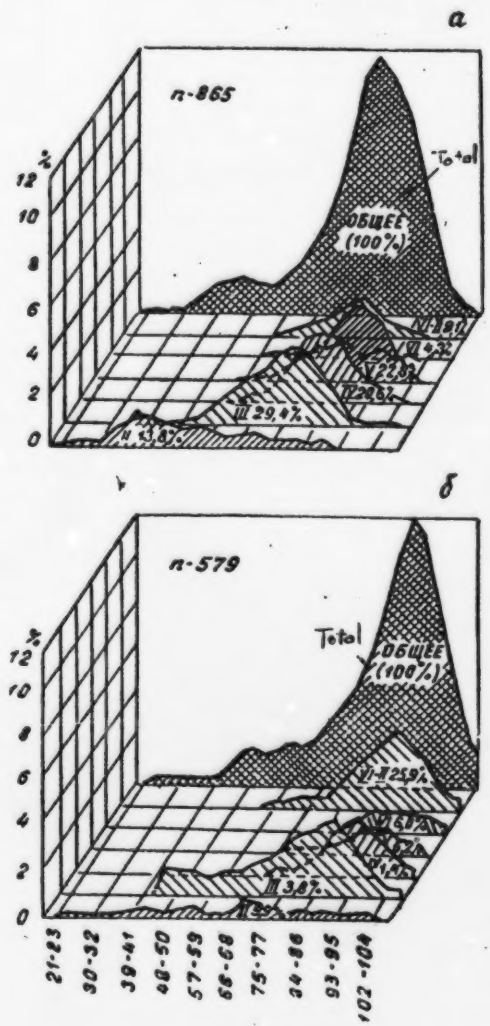

Fig. 6. Relative number of males (a) and females (b) of rock grenadier in various stages of sexual maturity on Hatton Bank in 1969, 1971, 1976 and 1979

On average, males mature when they reach a length of 76 cm, and females - when they reach 79 cm (Table 3).

At depths accessible to fishing, only sexually immature rock grenadier are encountered. Males always predominate among them (Table 4); however the sex ratio is subject to fluctuations between years (Savvatimsky, 1971, 1977; Savatimsky, Shafran, 1981) which are associated with the thermal regime of the water. Probably, the vertical distribution of individuals of different sexes, particularly females which predominate at deep levels on the continental slope, changes, depending on the temperature of the water. In fig. 7, the relative number of females is correlated with the average temperature in the 200-500 m and 500-1000 m layers on November 1 of each year at standard hydrological cross-section 8-A on the continental slope of southern Labrador. The water temperature results were averaged, based on three stations in 1966-1976 and two stations in 1977-1979 (Table 5).

Table 3

Average length and relative quantity of males and females of rock grenadier at different stages of maturity on Hatton Bank in 1969, 1971, 1976 and 1979

Stage of maturity	Length of males, cm		Number of fish		Length of females, cm		Number of fish	
	limits	average	number	%	limits	average	number	%
II	21— 92	54,1	119	13,8	24—104	70,0	57	9,9
III	39—107	75,8	255	29,4	45—110	79,4	221	38,0
IV	63—104	83,2	178	20,6	69—110	91,0	81	14,0
V	60—107	86,1	197	22,8	69—104	91,3	36	6,2
VI	60— 98	81,7	37	4,3	81—110	94,7	34	6,0
VI—II	57—101	79,5	79	9,1	57—110	88,3	150	25,9
Всего Total	21—107	77,3	865	100,0	24—110	84,1	579	100,0

Table 4

Quantity of females (%, numerator) of rock grenadier and investigated fish (numerator) in catches by year from 1967 to 1980

Year	Notre Dame Bay	Northern Labrador	Baffin Island	Western Greenland	Total
1967	36,7 / 1947	34,9 / 1806	31,6 / 3807	71,6 / 208	34,7 / 7768
1968	34,2 / 1225	39,9 / 3639	30,7 / 625	—	37,6 / 5489
1969	39,4 / 10437	40,6 / 350	29,1 / 8933	33,2 / 7440	34,3 / 21760
1970	37,0 / 400	—	30,2 / 8424	29,6 / 2650	30,3 / 11474
1971	37,3 / 1114	45,4 / 7588	25,4 / 3950	40,2 / 2954	38,8 / 15606
1972	33,4 / 2460	38,6 / 6937	32,5 / 12703	37,1 / 30275	36,0 / 52375
1973	40,3 / 11855	39,3 / 17162	26,3 / 2522	27,9 / 14708	35,2 / 46247
1974	46,7 / 1789	35,2 / 24941	28,3 / 9562	37,6 / 33010	35,7 / 69302
1975	40,8 / 3954	41,6 / 18182	34,8 / 2152	39,6 / 23852	40,2 / 48140
1976	—	38,1 / 17182	33,1 / 19228	34,6 / 47233	35,0 / 83643
1977	46,3 / 9611	42,1 / 12390	—	32,1 / 1890	43,0 / 23891
1978	38,1 / 6106	40,9 / 3959	—	—	39,2 / 10065
1979	43,7 / 1613	40,0 / 6574	34,0 / 3627	—	38,6 / 11814
1980	36,8 / 1987	45,4 / 1316	31,3 / 259	—	39,6 / 3562
1967—1980	40,5 / 54498	39,4 / 122026	31,0 / 75792	35,8 / 164220	36,6 / 416536

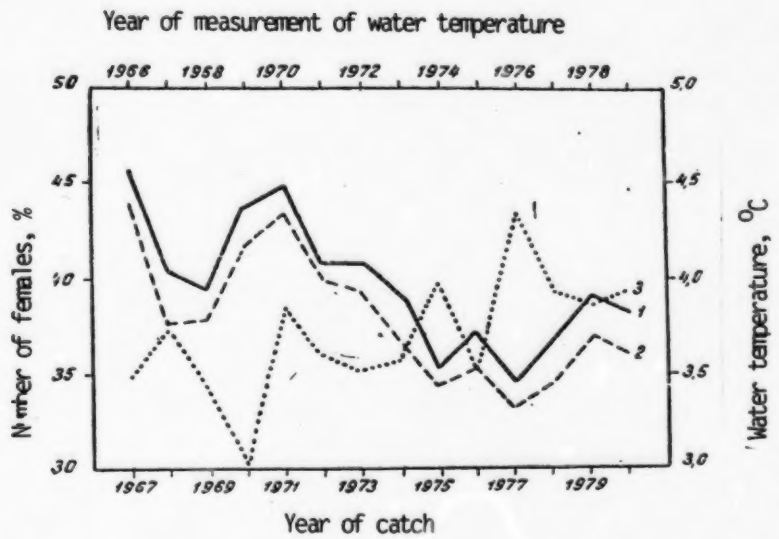

Fig. 7. Water temperature on November 1 in the 200-500 m layer (1) and 500-1000 m layer (2) on the continental slope of southern Labrador correlated with the relative quantity of females of rock grenadier (3) in the next calendar year in zones 3K, 2G and sub-regions 0 and 1

Table 5

The position of stations at which water temperature is measured in the 200-500 m and 500-1000 m layers

Years	Station number	Coordinates		Depth of sea, m
		N. lat.	W. long.	
	1	54°55′	53°22′5″	1550
1966—1976	2	55°00′	53°12′	2150
	3	55°13′	52°52′	2925
1977--1979	1	54°47′	53°00′	1306
	2	55°04′	52°30′	2636

Table 6

Quantity of females (%, numerator) of rock grenadier and fish studied (denominator) in catches by month from 1967 to 1980

Month	Notre-Dame Bay	Northern Labrador	Baffin Island	Western Greenland	Total
January	43,1 / 9963	40,2 / 199	30,9 / 786	43,7 / 3358	42,5 / 14306
February	42,0 / 50	—	—	32,2 / 152	34,7 / 202
March	47,8 / 538	23,5 / 51	—	—	45,7 / 589
April	49,0 / 100	—	—	50,5 / 218	50,0 / 318
May	42,1 / 2085	—	—	59,1 / 93	42,8 / 2178
June	43,1 / 2458	32,4 / 5572	—	40,1 / 3338	36,9 / 11368
July	38,1 / 11746	38,1 / 26899	32,9 / 5502	36,2 / 28551	36,9 / 72698
August	40,2 / 7102	40,6 / 18668	32,2 / 36880	35,8 / 33780	35,7 / 96430
September	32,3 / 251	39,8 / 36,7	28,5 / 22103	33,8 / 22057	35,1 / 81088
October	33,8 / 2777	38,8 / 12285	30,9 / 9113	28,4 / 22192	31,9 / 46367
November	39,8 / 12660	40,6 / 15824	30,7 / 1408	36,3 / 26015	38,2 / 55907
December	44,7 / 4768	43,5 / 5851	—	41,3 / 24466	42,2 / 35085
January - December	40,5 / 51498	39,4 / 122026	31,0 / 75792	35,8 / 164220	36,6 / 416536

We know that the water temperature predetermines the distribution of commercial fish which will be formed after several months or years. Asynchronous connections between hydrological and industrial indices were traced on the basis of capelin and cod (Konstantinov and Svetlov, 1974); therefore, we correlated water temperature with the relative quantity of rock grenadier females in the catches in the following calendar year (see Fig. 7). The coefficients of correlation between the water temperature in the 200-500 m and 500-1000 m layers and the relative quantity of grenadier females in the catches were -0.606 ± 0.175 and -0.582 ± 0.183, respectively. In the initial years, when the collection of material was irregular, no distinct interrelation is traced as in subsequent years in the course of the curves in Fig. 7. The coefficients of correlation between water temperature in the 200-500 m and 500-1000 m layers and the relative quantity of females in the last seven years were -0.664 ± 0.228 and -0.688 ± 0.215, respectively, i.e. they were higher than for the 14-year period.

If the hypothesis concerning the relationship between the relative quantity of grenadier females and water temperature is correct and is confirmed in subsequent years, it can be used for forecasting.

Seasonal changes were also noted in the sex compositions of catches (Table 6): the relative quantity of females in catches increases from January to April and then gradually decreases towards September-October, and it increases again towards the end of the year. It is entirely possible that this is associated with the seasonal migrations of females rising from deep levels of the continental slope and enlarging the concentration of grenadier at shallower levels.

Fig. 8 shows the relative quantity of grenadier females in catches /47
by month for 1967-1980 as a whole. The average quantity of females in the catches for all months was established at 39.24%. The largest percentage of females was

noted in April (45%), and the smallest - in September-October (34%). Apparently, this is also associated with the thermal regime of the water. Unfortunately, we have no data on the changes in water temperature throughout the entire year at the horizons of grenadier distribution, but we can assume the course of seasonal temperature is roughly similar at such depths and in the upper layers. /48

A distinct anti-phase state was revealed during the correlation of the relative quantity of grenadier females in 1967-1980 and water temperature at standard hydrological cross-section 4-A in the 0-200 m layer in 1955-1970, and also at station No. 27 at Saint Johns in the 10172 m layer in 1950-1962 (Burmakin, 1972). The coefficient of correlation between the relative quantity of females in the catches and the water temperature at cross-section 4-A was -0.891 ± 0.06; and at station No 27 -0.806 ± 0.106. The change in the relative quantity of females in the horizons being fished is relevant to the results of fishing because of the fact that the females are larger than the males; this is reflected on the assortment and value of the fish products produced. Judging by individual trawlings at depths of 1600-1700 m, females are more numerous than males in the micro-region of Notre Dame Bay. The same was noted for the Flemish Cap Bank as well. In March, 1978, the size of rock grenadier and its sex composition in catches taken on this bank by the scientific-industrial vessel Artemida changed sharply with the increased deapth of the catch. At depths of 1000-1180 m, the average length of the males was 56-59 cm, and of the females - 57-61 cm. At depths of 1240-1570 m, the average length of the males increased to 62-65 cm, and of the females - to 66-69 cm. Males predominated to a depth of 1360 m; at depths of 1400-1570 m, the females in the catch comprised 61%. A similar distribution of fish by sex in relation to depth was observed near Scotland (Gordon, 1978).

The male-female ratio varies greatly in catches taken in different /49 regions of the north Atlantic (from 100% males to 75% females) and is subject

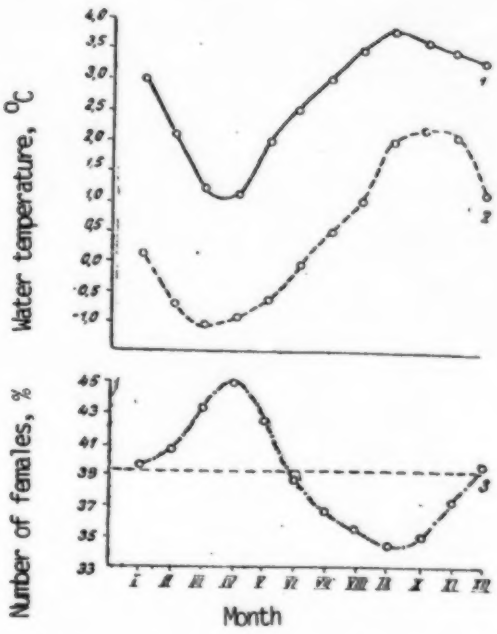

Fig. 8. the relationship between water temperature and the relative quantity of females of rock grenadier in catches according to the time of year: 1 - temperature at cross-section 4-A in the 0-200 m layer in 1955-1970; 2 - temperature at station No. 27 off Saint Johns in the 0-172 m layer in 1950-1962; 3 - relative quantity of females according to a smoothed-out series (solid line) and the average quantity of females (broken line) in catches in zones 3K, 2G and sub-zones 0.1 in 1968-1980

to considerable fluctuations with time. These fluctuations are especially great in the northeastern and north-central Atlantic - in the reproductive part of the accumulations being caught. An analysis of the sex ratio in the catches in each individual region shows that this ratio is determined by the behaviour of the fish, and in each relatively short period it may not reflect the sexual structure of the entire grouping that is caught. Generalized annual or long-term observations provide different results. We know that the sexual structure is one of the specific parameters of a population (Nikol'skii, 1974) and an analysis of it can reveal inter-population differences. A comparison of the curves describing the change in the sex ratio of the fish in

relation to their growth (size-sex structure) enables us to conclude that with time there are stable characteristics in individual regions and distinct differences in such characteristics between regions or banks. For example, the curves depicting the relative quantity of the males of rock grenadier in catches on Hatton Bank in 1976 and 1977 have a specific form and are very similar to the curve for 1978 (Fig. 9). The size-sex structure of grenadier of the northwest Atlantic is entirely different. The curves of the relative quantity of males of different lengths on Hatton Bank and in the regions of the northwestern Atlantic have significant differences (an evaluation based on the λ criterion of A.N. Kolomogorov and N.V. Smirnov with a fiducial probability of 0.95), and significant differences were not found between such curves in one and the same regions but in different years. Thus, for example, when comparing the relative quantity of males on Hatton Bank in 1976 and 1977, $\lambda = 0.92$, and in 1976 and 1987, $\lambda - 0.87$. When comparing such characteristics along Hatton Bank as a whole for 1976-1978 and in northern Labrador for 1967-1979, $\lambda - 1.5$.

Some differences exist in the size-sex structure of genadier in different parts of the continental slope of Canada (see fig. 9). But in all cases, males predominate quantitatively up to a certain length, but at a greater length the females predominate. A similar size-sex structure is characteristic of many fish, particularly cod (Konstantinov and Nevinskii, 1969). In the sub-region of Baffin Island, grenadier males predominate sharply in catches at lengths of up to 86 cm; at greater lengths, the females predominate. For the micro-region of northern Labrador a length of 81-83 cm is such a boundary in the male-female ratio, and for the micro-region of Notre Dame Bay - a length of 78-80 cm.

Thus, the differences in the sex ratio, size-sex structure, and degree and nature of their variation reflect the varied quality of local grenadier groupings. /50 The most important are the differences in these traits between the grenadier of

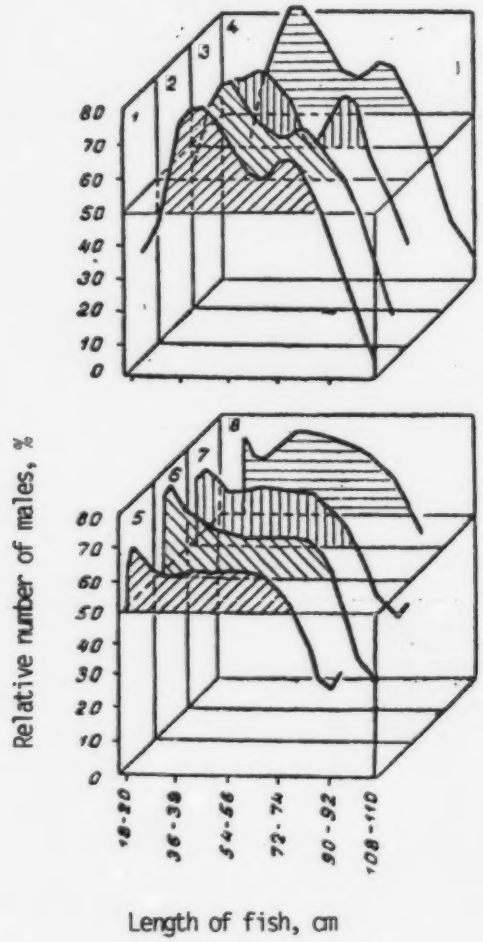

Fig. 9. The relative quantity of fish of different lengths in catches taken on Hatton Bank in 1976 - 45153 specimens (1); 1977 - 19755 specimens (2); 1978 - 2054 specimens (3); 1976-1978 - 66962 specimens (4); in the micro-region of Notre Dame Bay, 1967-1978 - 39722 specimens (5); northern Labrador, 1967-1979 - 120282 specimens (6); western Greenland, 1967-1977 - 161955 specimens (7); Baffin Island, 1967-1979 - 75323 specimens (8)

Hatton Bank and the grenadier caught on the continental slope of Canada. In order to determine the boundaries between these groupings and the degree of their reinforcement as a result of the transport of eggs and larvae with the ocean currents, additional studies are necessary.

Conclusions. The spawning of rock grenadier apparently occurs at deep levels away from the continental slopes. Grenadiers do not make extended spawning or feeding migrations. The eggs are supplied with a fat drop, and they float in the sub-surface layers of water where they develop; as the larvae grow they descend to deep waters. Spawning is greatly extended and is most intensive from June to December.

Grenadier males mature when they reach an average length of 76 cm, and females - 79 cm. Fecundity is approximately 30 thousand eggs. Eggs that are ready to be spawned have a diameter of 2-2.5 mm. Fecundity increases with increase in the length and weight of rock grenadier according to the patterns characteristic of most fish which spawn one time.

The sex composition of grenadier catches changed from 1967 to 1980, /51 corresponding to changes in water temperature in the main branch of the Labrador current; this is apparently explained by the vertical migrations of the females. Distinct seasonal changes occur in the sex composition of the catches, which is probably also associated with the thermal conditions of the environment. Seasonal changes in the sex composition of catches are reflected on the assortment and value of the produced fish products, since the females are larger than the males.

In various regions of the northwestern Atlantic and on Hatton Bank, differences have been found in the sex ratio of the fish, the size-sex structure, and the degree and nature of their changeability, testifying to the heterogeneity of quality of local groupings of rock grenadier. The most important differences

in these characteristics exist in the grenadier of Hatton Bank and the continental slope of Canada.

The otoliths of the grenadier of the northern and southern parts of Reykjanes Ridge differ in form. A weight analysis of the otoliths shows that the grenadier living in various regions of the northern Atlantic have significant differences and possibly form local populations which can be reinforced as a result of the transport of eggs and larvae by currents.

References

1. Alekseeva, Ye.I. Features of gametogenesis, type of spawning and reproductive cycle of the grenadier (Macrouridae, Pisces) in relation to the colonization of bathypelagial zone. In: Aspects of the early ontogeny of fish. II All-Union Conference. Kiev, "Naukova dumka, 1978, pp. 73-74 (Abstracts of reports)

2. Alekseev, F.Ye., Ye.I. Alekseeva and N.V. Titova. A polyform system of muscular esterase, the ecological structure of colonization, and a study of the species structure in the grenadier (Macrurus rupestris Gunn.) In: Abstracts of reports presented at the II All-Union Conference on the biochemical genetics, karyologic polymorphism and mutagenesis of fish (14-17 March, 1978, Leningrad). Moscow, 1978, pp. 19-20.

3. Andriyashev, A.P. Fish of the northern seas of the USSR. Izd-vo AN SSSR, Moscow/Leningrad, 1954, 566 pp.

4. Vinichenko, V.I. Effect of hydrologic factors on the behaviour of rock grenadier of the open part of the Atlantic Ocean. In: State of the reserves and population dynamics of the pelagic fish of the World Ocean. Kaliningrad, 1979, pp. 20-21. (Abstracts of reports).

5. Vinogradov, M.Ye. Vertical migrations of deep-sea zooplankton. In: Scientific results (achievements of oceanology). No. 1, Moscow, Izd-vo AN SSSR, 1959, pp. 213-240.

6. Grigor'ev, G.V. The reproduction of rock grenadier of the northern Atlantic. Trudy PINRO, 1972, No. 28, pp. 107-115.

7. Zakharov, G.D. and I.D. Mokanu. Distribution and biological characteristics of rock grenadier (Macrurus rupestris) of Davis Strait in August and September of 1969. In: Present state of the biological productivity and raw-material biological resources of the World Ocean and the prospects of their use. Kaliningrad, 1970, pp. 146-154.

8. Kleie, Ye.F. Grenadiers, Central Office of Technical Information, "Dal'ryba", Vladivostok, 1967. 18 pp.

9. Konstantinov, K.G. and M.M. Neinskii. Sex ratio of Atlantic cod. Voprosy ikhtiologii, 1969, Vol. 9, No. 4 (57), pp. 758-760.

10. Konstantinov, K.G. and I.I. Svetlov. On the temporal relationship between water temperature and the distribution of commercial marine fish. Okeanologiya, 1974, Vol. 14, No. 2, pp. 349-354.

11. Kulikov, Ye.B. Growth and age of deep-sea fish. Trudy Instituta okeanologiya [illegible] AN SSSR, 1957, Vol. 20, pp. 347-355.

12. Lisovenko, L.A. Fecundity of the grenadier Coryphaenoides holotrachus (Günther) of the Falkland-Patagonia region and its relationship with the length and weight of the females. Voprosy ikhtiologii, 1980, Vol. 20, No. 5 (124), pp. 954-956.

13. Nikol'skii, G.V. Theory of the dynamics of fish stock as the biological basis of the rational exploitation and reproduction of fish resources. Moscow, "Pishchevaya promyshlennost', 1974, 447 pp.

14. Novikov, N.P. Biology of the smalleye grenadier (Chalinura pectoralis) in the northern part of the Pacific Ocean. "Trudy VINRO", 1970, Vol. 70, pp. 300-325.

15. Novikov, N.P. and A.S. Kodolova. Biology and distribution of the smalleye grenadier Nematonurus pectoralis. In: Abstracts of the reports presented

at the inter-basin symposium of aspects of the biology, fishing and use of Greenland halibut, and grenadier. Murmansk, PINRO, 1973, pp. 16-17.

16. Pechenik, L.N. On the operations of northern commercial survey in 1968. Contributions to the studies of fisheries in the Northern Basin, 1970, No. 16, Part 1, pp. 11-19.

17. Pechenik, L.N. and F.M. Troyanovskii. Rock grenadier. Rybnoe khozaistvo, 1969, No. 12, pp. 7-9.

18. Pechenik, L.N. and F.M. Troyanovskii. Raw material base of trawl fishing on the continental slope of the northern Atlantic. Murmansk, Kn. izd-vo, 1970. 86 pp.

19. Polutov, I.A., I.I. Lagunov and I.I. Kurenkov. Commercial fish and invertebrates of the Pacific Ocean. Petropavlovsk-Kamchatka, Dal'nevostochnoe kn. izd-vo, 1980. 95 pp.

20. Rass, T.S. Deep-sea fishes. In: Scientific results (achievements of oceanology). No. 1, Moscow, Izd-vo AN SSSR, 1959, pp. 283-315.

21. Savvatimskii, P.I. Grenadier of the northern Atlantic. Murmansk, Kn. izd-vo

22. Savvatimskii, P.I. On the age of rock grenadier of the northwestern Atlantic and the possible effect of fishing on its population. Trudy PINRO, 1972, No. 28, pp. 116-127.

23. Serebrov, L.I. Study of the behaviour of arctic cod and rock grenadier with the help of a camera attached to the trawl. Rybnoe khozyaistvo, 1974, No. 11, pp. 6-8.

24. Trunov, I.A. Some aspects of the biology of Coelorhynchus Fasciatus (Macrouridae) of the southeastern Atlantic. In: Abstracts of reports presented at the inter-basin symposium on aspects of the biology, fishing and use of Greenland halibut and grenadier. Murmansk, PINRO, 1973, pp. 11-14.

25. Yanulov, K.P. Concerning the question of the locality of

perch populations in the regions of Newfoundland and Labrador. In: Soviet fisheries research in the seas of the European North. Moscow, Rybnoe khozyaistvo, 1960, pp. 299-307.

26 - 31. See original bibliography. Tr.

32. Ibanez, M. Contributions to the study of the biology and growth of deep-sea benthic fish Trachyrhynchus trachyrhynchus (Risso) in the Mediterranean and northesat Atlantic.

33 - 39. See orginal bibliography. Tr.

40. Sanzo, L. Teleostei, Macruridae eggs, larvae and juveniles.

41 - 44. See original bibliography. Tr.

45. Szuks, H. On the parisitization of Macrourus rupestris (Gunnerus) from the region of Labrador by digenetic trematodes.

46. Szuks, H. The usability of parasites for group separation in the grenadier Macrourus rupestris.

47. Zukowski, Cz. The possibility of rational utlization of grenadier stocks.

ЛИТЕРАТУРА

1. Алексеева Е. И. Особенности гаметогенеза, тип нереста и половой цикл макруруса (Macrouridae, Pisces) в связи с освоением батипелагиали. — В кн.: Вопросы раннего онтогенеза рыб. II Всесоюзная конференция. Киев, «Наукова думка», 1978, с. 73—74. (Тезисы докл.).

2. Алексеев Ф. Е., Алексеева Е. И., Титова Н. В. Полиформная система мышечных эстераз, экологическая структура поселения и исследование структуры вида у макруруса (Macrurus rupestris Gunn.). — В кн.: Тезисы докладов II Всесоюзного совещания по биохимической генетике, кариологическому полиформизму и мутагенезу у рыб (14—17 марта 1978 г., Ленинград). М., 1978, с. 19—20.

3. Андрияшев А. П. Рыбы северных морей СССР. Изд-во АН СССР, М.—Л., 1954. 566 с.

4. Виниченко В. И. Влияние гидрологических факторов на поведение тупорылого макруруса открытой части Атлантического океана. — В кн.: Состояние запасов и динамика численности пелагических рыб Мирового океана. Калининград, 1979, с. 20—21. (Тезисы докл.).

5. Виноградов М. Е. Вертикальные миграции глубоководного зоопланктона. — В кн.: Итоги науки (Достижения океанологии). Вып. 1, М., Изд-во АН СССР, 1959, с. 213—240.

6. Григорьев Г. В. О размножении тупорылого макруруса Северной Атлантики. — «Труды ПИНРО», 1972, вып. 28, с. 107—115.

7. Захаров Г. П., Мокану И. Д. Распределение и биологическая характеристика тупорылого макруруса (Macrurus rupestris) Девисова пролива в августе—сентябре 1969 г. — В кн.: Современное состояние биологической продуктивности и сырьевых биологических ресурсов Мирового океана и перспективы их использования. Калининград, 1970, с. 146—154.

8. Клейе Е. Ф. Макрурусы. ЦБТИ, «Дальрыба», Владивосток, 1967. 18 с.

9. Константинов К. Г., Невинский М. М. Соотношение полов у атлантической трески. — «Вопросы ихтиологии», 1969, т. 9, вып. 4 (57), с. 758—760.
10. Константинов К. Г., Светлов И. И. О временной связи между температурой воды и распространением морских промысловых рыб. — «Океанология», 1974, т. 14, вып. 2, с. 349—354.
11. Куликова Е. Б. Рост и возраст глубоководных рыб. — «Труды ИО АН СССР», 1957, т. 20, с. 347—355.
12. Лисовенко Л. А. Плодовитость макруруса Coryphaenoides holotrachus (Günther) Фолклендско-Патагонского района и ее зависимость от длины и веса самок. — «Вопросы ихтиологии», 1980, т. 20, вып. 5 (124), с. 954—956.
13. Никольский Г. В. Теория динамики стада рыб как биологическая основа рациональной эксплуатации и воспроизводства рыбных ресурсов. М., «Пищевая промышленность», 1974. 447 с.
14. Новиков Н. П. Биология малоглазого долгохвоста (Chalinura pectoralis) в северной части Тихого океана. — «Труды ВНИРО», 1970, т. 70, с. 300—325.
15. Новиков Н. П., Кодолов А. С. Биология и распределение малоглазого макруруса Nematonurus pectoralis. — В кн.: Тезисы докладов межбассейнового симпозиума по проблемам биологии, промысла и использования черного палтуса и макруруса. Мурманск, ПИНРО, 1973, с. 16—17.
16. Печеник Л. Н. О работе Северной промысловой разведки в 1968 г. — «Материалы рыбохозяйственных исследований Северного бассейна», 1970, вып. 16, ч. 1, с. 11—19.
17. Печеник Л. Н., Трояновский Ф. М. Тупорылый макрурус. — «Рыбное хозяйство», 1969, № 12, с. 7—9.
18. Печеник Л. Н., Трояновский Ф. М. Сырьевая база тралового рыболовства на материковом склоне Северной Атлантики. Мурманск, Кн. изд-во, 1970. 86 с.
19. Полутов И. А., Лагунов И. И., Куренков И. И. Промысловые рыбы и беспозвоночные Тихого океана. Петропавловск-Камчатский, Дальневосточное кн. изд-во, 1980. 95 с.
20. Расс Т. С. Глубоководные рыбы. — В кн.: Итоги науки (Достижения океанологии). Вып. 1, М., Изд-во АН СССР, 1959, с. 283-315.
21. Савватимский П. И. Макрурус Северной Атлантики. Мурманск, Кн. изд-во, 1969. 72 с.
22. Савватимский П. И. О возрасте тупорылого макруруса Северо-Западной Атлантики и возможном влиянии промысла на его численность. — «Труды ПИНРО», 1972, вып. 28, с. 116—127.
23. Серебров Л. И. Изучение поведения полярной тресочки и тупорылого макруруса с помощью притраловой фотокамеры. — «Рыбное хозяйство», 1974, № 11, с. 6—8.
24. Трунов И. А. Некоторые вопросы биологии Coelorhynchus fasciatus (Macrouridae) Юго-Восточной Атлантики. — В кн.: Тезисы докладов межбассейнового симпозиума по проблемам биологии, промысла и использования черного палтуса и макруруса. Мурманск, ПИНРО, 1973, с. 11—14.
25. Янулов К. П. К вопросу о локальности стад окуней районов Ньюфаундленда и Лабрадора. — В кн.: Советские рыбохозяйственные исследования в морях Европейского Севера. М., «Рыбное хозяйство», 1960, с. 299—307.
26. Burmakin V. V. Seasonal and year to year variations in water temperature in the Labrador and Newfoundland areas. ICNAF Spec. Publ. No. 8, 1972, p. 63—70.
27. Geistdoerfer P. Contribution a la biologie de Coryphaenoides rupestris. Repartition et reproduction dans L'Atlantigue nord-est. — ICES C. M. 1977/F:45.
28. Gordon J. D. M. Some notes on the biology of the roundnose grenadier Coryphaenoides rupestris to the West Scotland. — ICES C. M. 1978/G:40.
29. Grigor'ev G. V., Serebryakov V. P. Eggs of the rock grenadier, Coryphaenoides rupestris Gunnerus 1765. — NAFO SCR Doc. 81/VI/75, 1981, Ser. No. N 360.

30 Hubbs C. L. Iwamoto T. A new genus (Mesobius), and three new bathypelagic spesies of Macrouridae (Pisces, Gadiformes) from the Pacific ocean. — Calif. Acad. Sci., Fourth series, 1977, vol. 41, No. 7, p. 223—251.
31 Hureau J., Geistdoerfer P., Rannou M. The ecology of deep-sea benthic fishes. — Sarsia, 1979, vol. 64, No. 1—2, p. 103—108.
32 Ibanez M. Contribution al estudio de la biologia y cracimiento de un pez batibentico Trachyrhynchus trachyrhynchus (Risso) en el Mediterraneo y Atlantico N. E. — Notas ictiologicas 4. Minibe sociedad de Ciencias Aranzadi. San. Sebastian, Ano 29, No. 3—4, 1977, p. 213—230.
33 Isaacs J. D., Schwartzlose R. A. Active animals of the deep-sea floor. — Sci. Amer., 1975, vol. 233, No. 4, p. 85—91.
34 Jensen A. S. Contributions to the ichthyofauna of Greenland. Spolia Zool. Mus. Hauniensis, Bd. 9, 1948. 182 p.
35 Johnson S. On some bathypelagic stages of Macrurid fishes. Nyt. Mag. naturvidensk., 1972, Bd. 65, p. 221—242.
36 Magnusson J. V. Some notes on the spawning habits of Macrouridae at Iceland. — ICES C. M. 1977, F:49.
37 Marshall N. B. Systematic and biological studies of the Macrourid fishes (Anacanthini-Teleosteit). — Deep-Sea Rer. 1965, vol. 12, No. 3, p. 299—322.
38 Merrett N. R. On the identity and pelagic occurrence of larval and juvenule stages of rattail fishes (Family Macrouridae) from 60°N, 20°W and 53°N, 20°W. — Deep-Sea Res., 1978, vol. 25, No. 2, p. 147—160.
39 Podrazhanskaya S. G. Feeding and migrations of the roundnose grenadier, Macrourus rupestris, in the Northwest Atlantic and Iceland waters. — ICNAF Res. Doc. 71/89, 1971, Ser. No. 2564.
40 Sanzo L. Ova, larve et stadi giovanili di Teleostei, Macruridae. — Fauna et Flora del Golfo di Napoli, 1933, No. 38, p. 255—256.
41 Savvatimsky P. I. Studies of the age and growth of roundnose grenadier (Macrourus rupestris Gunn.) in the North Atlantic, 1967—1970. — ICNAF Redbook, 1971, part 3, p. 125—138.
42 Savvatimsky P. I. Prospects of roundnose grenadier fishery in the Northwest Atlantic. — ICNAF Res. Doc. 77/VI/30, 1977, Ser. No. 5055.
43 Savvatimsky P. I., Shafran I. S. Status of roundnose grenadier stock and possibilities for their commercial removal in the Northwest Atlantic. — NAFO SCR Doc. 81/IX/106, 1981, Ser. No. N410.
44 Stein D. Description and occurrence of macrourid larvae and juveniles in the northeast Pacific Ocean off Oregon, U.S.A. — Deep-Sea Res., A27, No. 11, 1980, p. 889—900.
45 Szuks H. Zum Befall von Macrourus rupestris (Gunnerus) aus dem Bereich von Labrador mit digenen Trematoden. — Wiss. Z. Päd. Hochsch. «Lise-lotte-Herrmann» Güstrow., Math. — Naturwiss. Fak., 1975, Bd. 2, p. 225—231.
46 Szuks H. Die verwendbarkeit von parasiten zur gruppentrennung beim grenadierfisch Macrourus rupestris. — Angew. Parasitol. Bd. 21, Nr. 4, 1980, p. 211—214.
47 Zukowski Cz. Mozliwosci racjonalnego wykozzystanid zasobow tyb bufawikowatvch. — Biuletyn M I.R. Nr. 1/9, Gdvnia, 1972, p. 3—6.